# Chapter 11
# Introducing Fertilisers

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# 11 Introducing Fertilisers

## 11.1 Introduction

In this Chapter:


Fertilisers come in many forms (for example, liquid, granular and organic) and can contain one or more of the nutrients required by plants. When you know what nutrients your pastures need, you must then find the fertiliser or fertilisers that can supply those nutrient needs.

## 11.2 What is a fertiliser?

A fertiliser is any material added to the soil or applied to a plant to improve the supply of nutrients and promote plant growth.

Any natural or manufactured material that contains at least 5% of one or more of the three primary nutrients - nitrogen (N), phosphorous (P), or potassium (K) - can be considered a fertiliser. Industrially manufactured fertilisers are sometimes referred to as "mineral" fertilisers. Fertilisers contain varying proportions of plant essential major (N, P, K, etc.) and minor (Zn, Mn, Fe, etc.) elements, as well as impurities and other non-essential elements. This definition includes both inorganic (mineral) and organic fertilisers and also soil conditioners, such as lime and gypsum (discussed in Chapter 7), which may promote plant growth by increasing the availability of nutrients that are already in the soil or by changing the soil's physical structure.

## 11.3 Fertiliser products

Prior to the mid-1960s, only a limited range of fertiliser products was available in Australia. Advances in agricultural and manufacturing technology have resulted in a wider range of fertiliser products, and new terms are now being used to describe the fertilisers on the market.

Today, the term *fertiliser* is applied to a number of products. Those called *inorganic fertilisers* (sometimes called commercial, synthetic or artificial fertilisers) mostly contain chemicals with the essential plant nutrients in available forms, the production of which involves some industrial process. Examples include urea, superphosphate and muriate of potash. *Organic fertilisers* are made up of organic material containing carbon from animal and plant products. Examples of organic fertilisers include: animal manures, dairy and dairy factory effluent (refer to Chapter 13), compost and blood and bone.

The main terms used to describe fertilisers are further discussed below.

### 11.3.1 Low-analysis fertilisers

Low-analysis fertilisers are the less concentrated products. They have a lower percentage of nutrients in their analysis. Examples include single superphosphate. These products are made using a different manufacturing process to that used to make high-analysis fertilisers. As a result, they have higher sulphur levels than the high-analysis fertilisers; and it is usually in the form of sulphate sulphur, which is readily available to plants.

### 11.3.2 High-analysis fertilisers

High-analysis fertilisers are the more concentrated products. They have a higher percentage of nutrients in their analysis. They cost more per tonne to purchase because they are more concentrated, but spreading and freight costs are reduced because you need less product to apply the same quantity of nutrient per hectare. An example of a high-analysis fertiliser is triple superphosphate.

### 11.3.3 Straight fertilisers

The term straight fertilisers is a bit misleading and not regularly used. It is more commonly used by the manufacturers in the factories. It is used to describe fertilisers that contain only one of the macronutrients, such as urea which contains nitrogen, or muriate of potash which contains primarily potassium.

Many of the ‘straight’ fertilisers, such as single superphosphate and sulphate of ammonia, also contain other essential nutrients, such as sulphur.

### 11.3.4 Compound fertilisers

Compound fertilisers are products that have been manufactured by a chemical reaction and contain two or more of the major nutrients. All granules are similar in size and contain the same nutrients. They are generally more expensive per tonne but not on a per kg nutrient basis than mixed or blended fertilisers. Examples include di-ammonium phosphate (DAP) and mono-ammonium phosphate (MAP).

### 11.3.5 Blended fertilisers or mixed fertilisers

Blended fertiliser is the term applied to fertilisers that are a physical mixture of one or more of the ‘straight’ or compound fertilisers. Examples include SuPerfect Potash 3 & 1, PastureBoosta, Greentop K, and HayBoosta. The fertiliser companies are now able to provide a wide range of blended products to suit specific nutrient requirements. Many of their blends are listed on their product list. You would need to contact them regarding the cost of special ‘prescription blends’; that is, blends with stipulated types and proportions of nutrients (See Appendix F for a range of online product lists, including blends).

The final analysis of blended products will be the result of the overall proportions of the various products not simply an addition of the percentages.

For example: Super Potash 2 & 1 is a blend of two parts single superphosphate (each containing 8.8% P) and one part muriate of potash (which is 50% K). It’s like putting two bags of superphosphate plus one bag of muriate of potash into a spreader and then mixing them together.

In essence you have two granules of single super phosphate containing 8.8% P for each granule of muriate of potash containing 50% K – Refer Figure 11.1.

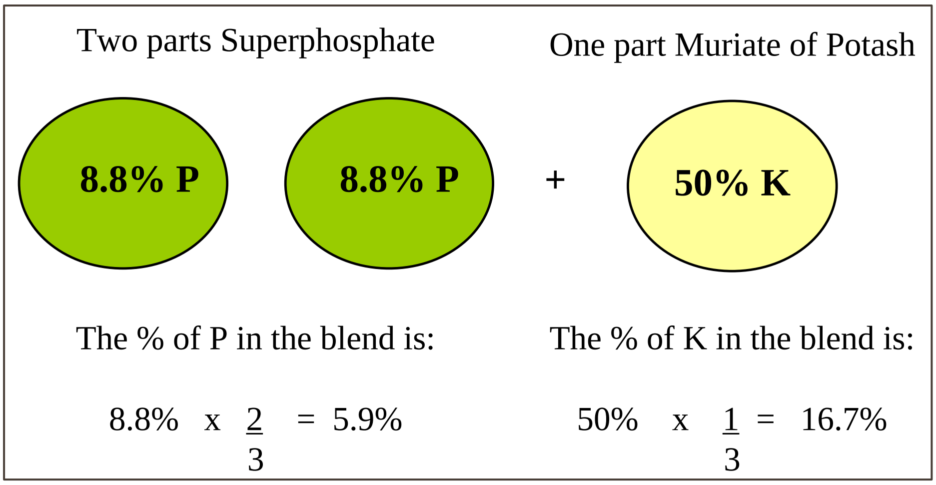


**Figure 11.1** Diagrammatic representation of Super Potash 2 & 1 in granular form

## 11.3.6 NP and NPK fertilisers

The terms NP fertiliser and NPK fertiliser are often used in conjunction with the term ‘mixture’ or ‘compound’. They refer to fertilisers that contain nitrogen and phosphorus (NP) or nitrogen, phosphorus and potassium (NPK). See Chapter 12 for more information on nitrogen and nitrogen fertilisers.

## 11.3.7 Granulated or pelleted fertilisers

Granulated fertiliser or pelleted fertiliser is a term applied to fertilisers that have been treated in such a way that they form granules to improve handling and spreading.

Granulation provides a number of advantages: it reduces the quantity of fine particles in a fertiliser, and it increases the flow and ease of spreading.

## 11.3.8 Organic fertilisers

The term *organic fertiliser* generally refers to fertilisers supplied or manufactured from animal or plant by-products. Examples include blood and bone, compost, chicken manure, dairy effluent and fishmeal products. There are, however, blurred definitions of what exactly is an organic fertiliser. This is because other fertilisers not from animal or plant by-products, can be classified as Australian Certified Organic, including potassium sulphate, reactive rock phosphate and seaweeds.

Nutrients contained within organic fertilisers will be released at varying rates depending on the complexity of how they are bound, their form and solubility within the fertiliser. Some nutrients can be released quite rapidly (e.g. potassium and nitrates) however, in general organic fertilisers tend to be slower releasing than mineral fertilisers. In other words, it takes time for the nutrients to become available in the soil for plants. They also usually contain fewer nutrients per kilogram than the inorganic fertilisers.

Organic fertilisers supply varying quantities of the major nutrients: nitrogen, phosphorus, potassium and sulphur, as well as some trace elements; and their composition can be quite variable. Generally, unless using very high application rates, the kg/ha of a plant available nutrient provided from organic fertilisers is low and may not keep up with crop removal. Hence conventional mineral fertilisers may also be required to balance soil nutrients and to maintain optimal soil fertility. They also contribute some organic carbon to the soil, which may improve the soil structure. Table 11.1 shows the averages and ranges of the major nutrients (N, P, and K) for a variety of animal manures.

**Table 11.1** 'Typical' nutrient analyses (dry matter basis) for animal manures (average and ranges)

| SOURCE | NITROGEN (%) | PHOSPHORUS (%) | POTASSIUM (%) | MOISTURE (%) |
|---|---|---|---|---|
| Poultry (cage) | **3.4** (2.8 - 4.8) | **2.5** (1.9 - 4.0) | **1.5** (1.2 - 2.1) | **35** (15 - 65) |
| Poultry (litter) | **2.6** (1.4 - 4.2) | **1.8** (1.6 - 2.8) | **1.0** (1.1 - 1.9) | **25** (10 - 51) |
| Cattle | **1.5** (0.7 - 2.5) | **0.5** (0.2 - 1.4) | **1.2** (0.7 - 1.8) | **40** (9 - 54) |
| Horse | **1.2** (1.0 - 1.5) | **0.2** (0.1 - 0.4) | **0.8** (0.3 - 1.0) | **35** (6 - 62) |
| Sheep | **1.7** (1.3 - 2.6) | **0.5** (0.3 - 0.8) | **1.2** (0.6 - 2.5) | **30** (8 - 60) |
| Pig | **2.3** (1.4 - 2.7) | **2.3** (1.4 - 3.7) | **0.6** (0.2 - 1.3) | **60** (50 - 76) |

**Note:** Moisture content must be taken into account when costing the nutrients provided in organic fertilisers and when calculating the rate of the spread nutrients.

For more information on organic fertilisers:
Poultry manure
Making the most of animal by-products
Composting Spoiled Hay
Compost
Dairy Effluent – See Chapter 13.

There has been interest recently in the use of various humic substances in agriculture, namely **humic acids and fulvic acids**. Humic substances are the major part of humus. They are naturally occurring products found in soils and other places that are the result of the decomposition of plant and animal residues. Humic acids are generally used either in a liquid form when applied to plant foliage, or in a solid form when spread and incorporated into soil. Humic and fulvic acids are generally combined with other synthetic inputs to form a commercial product.

There are numerous advantages attributed to these two humic substances including:

- Enhanced soil structure and fertility through the addition of vital organic matter in the soil;
- Efficient transfer of fertiliser nutrients and micronutrients;
- Increased microbial and enzyme activity in the soil;
- Increased plant availability of nutrients like phosphorus;
- Increased moisture holding capacity of soil; and
- Increased cation exchange capacity within the soil

However caution is urged to try these products first in a "test strip" capacity (See Chapter 8.6 for information on setting up test strips).

## 11.3.9 Trace elements or micronutrients

Trace elements or micronutrients are the terms applied to the essential elements for plant growth and animal health that are required in only small quantities. Trace elements can be added to most fertilisers to meet particular needs. The most commonly added trace elements in eastern Australia are molybdenum, copper, zinc, boron, selenium, and cobalt. It is rare, however, for all these trace elements to be required at the same time, or to be added in one product. See Chapter 3.4 for more information on trace elements.

### 11.3.10 Slow-release fertilisers

In order to better synchronise the availability of nutrients to plant demand and, in doing so, increase nutrient use efficiency, slow-release fertilisers have been developed. These fertilisers have been produced in such a way that they are not readily water soluble. Treatment usually involves coating the fertiliser granules with a slowly soluble material, such as sulphur or wax. Because of the extra processes involved in coating the granule, these products are usually more costly than non-coated products. Examples of **coated slow-release fertilisers** include horticultural products, such as Osmocote.

**Reactive rock phosphates** are very slow release in that they dissolve slowly in acid soils to become available to plants naturally. Similarly, elemental sulphur must be converted to the plant-available sulphate sulphur form before it can be used by plants. Therefore, elemental sulphur is also considered a slow-release fertiliser compared to sulphate sulphur.

Fertilisers are now commercially available that modify or reduce the rate by which fertiliser nitrogen becomes plant available. Known as **nitrification inhibitors**, they have specific coatings or treatments that work by slowing the release of nutrients, or by delaying the conversion to less stable forms. The slower release of nitrogen during the nitrification process, and potentially greater nutrient use efficiency, is due to the inhibition of specific enzymes and nitrifying bacteria. By inhibiting these enzymes, more nitrogen is retained in the stable ammonium ($NH_4^+$) form. The effect of the inhibitors on specific nitrifying bacteria reduces the amount of the very soluble nitrate nitrogen which can be more readily lost through leaching and denitrification. For more information on the nitrification process and denitrification refer to Chapter 12.

### 11.3.11 Liquid fertilisers

Liquid fertilisers refer to nutrient solutions, suspensions and slurries and are usually sprayed onto pastures. According to the *Dairying for Tomorrow Survey* they are not widely used in the Australian dairy industry, apart from the spreading of dairy effluent (Dairy Australia, 2012). However, some nitrogen solutions are gaining popularity in northern Victoria, especially through fertigation under centre pivots.

### 11.3.12 Alternative fertilisers

The term *alternative fertiliser* refers to those products that fall outside the category of products generally known as fertilisers to the farming community.

Many products, making a wide range of beneficial claims, continually arrive on the market. When prices of conventional fertilisers rise, it is often tempting for some farmers to look towards alternatives. It is sometimes difficult to know whether alternative fertilisers will perform as claimed by the company. There are a number of checks that can be done to avoid costly mistakes, including the following:

- Ask for the nutrient analysis, and check the analysis was conducted by a reputable testing laboratory.
- Compare the product nutrient analysis, the form or plant availability of each nutrient, and the cost per kg of nutrients with other fertilisers - Refer to Section 11.4.1 and Chapter 14 to work out nutrient costs.
- Check that nutrients contained in the product are required by the soil, plant or livestock.

- Ask for the research to back the product claims. Question the credibility of the research – was it a simple side by side demonstration or a replicated trial? Where was the research done – Australia or overseas? Was it conducted by an independent organisation? Was the research peer reviewed? Is it only anecdotal observation?
- Sometimes products may make claims which cannot be explained by their nutrient content or fertiliser value. In these cases, if the product works it would be due to some growth promotant effect and could not be directly compared with traditional fertilisers or manures. If you believe the products could be beneficial, but there is no existing product analysis or credible research to back the claims, reduce the risk by trialling the product with fertiliser test strips. Always include a nil strip and, if possible, include a standard product for comparison - Refer to Chapter 8.7 for details on setting up a fertiliser test strip.

Other alternative fertilisers include the various forms of manures, composts and biosolids. These have increased in popularity due to commercial fertiliser price rises and their contribution to soil health. It is important to weigh up the costs and benefits of alternative fertilisers in comparison to other products.

**Biosolids,** whilst being an attractive nutrient source, currently have to be incorporated into the soil within hours of application for legal and health reasons. This is obviously not feasible for pastures. In addition, there are concerns about substantial nutrient losses (nitrogen) and nutrient accumulations (trace elements and phosphorus) when this product is applied to the soil.

**Manures and composts** when applied to pastures will provide a range of nutrients (See Table 11.1) some being immediately available and others requiring decomposition before becoming plant available. The application of manures and composts to crops and pastures should not be on the basis of ‘’getting rid of a waste product” but applied in accordance with soil nutrient requirements (See Chapter 15, Nutrient Planning). .

# 11.4 Nutrient analysis of fertiliser products

When applying fertilisers it is important to be clear about the terms used. There are many colloquial and imperial terms lingering which can add to the confusion and create errors; for example, bags/acre or so many units of a particular nutrient.

As suggestions, when making **fertiliser recommendations**:

- Use the amount of *fertiliser product* per hectare; e.g. urea at 100 kg/ha.
- **Do not** mix imperial and metric measurements; e.g. kg/acre
- Keep in metric if possible
- Keep numbers rounded to nearest “0” or “5”; e.g. 10 kg/ha or 15kg/ha not 13.2 kg/ha.

Appendix A contains conversion tables to help you convert fertiliser application rates and weights from the imperial system to the metric system. Appendix B contains explanatory information about the metric system.

## 11.4.1 NPKS system

The NPKS system describes the **nutrient analysis** of a fertiliser in terms of the percentage of nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) that it contains. By law, the NPKS nutrient analysis must be displayed on the fertiliser product label and on the fertiliser company’s product list - See Appendix F for examples of product lists. This system allows you to quickly and accurately see what nutrients the product contains and calculate the amount (weight) of each nutrient in the product.

NPKS nutrient analyses are often written with a colon (:) between each percentage. For example, the nutrient analysis for single superphosphate is 0:8.8:0:11, which means 0% nitrogen, 8.8% phosphorus, 0% potassium, and 11% sulphur. When the nutrient analysis is written this way, it always gives the nutrient percentages in the same order: N, P, K and S. The analysis of commercial fertilisers can be easily obtained from a product list for each fertiliser company (See Appendix F).For an analysis of common fertilisers please refer to Appendix G

The amount (weight) of N, P, K and S nutrients in a fertiliser product can be calculated from the percentages given in the nutrient analysis. 'Per cent' means 'in every hundred', so, 8.8% means 8.8 in every hundred, and 11% means 11 in every hundred.

For example, 100 kg of single superphosphate with a nutrient analysis of 0:8.8:0:11 will contain:

| | | | |
|---|---|---|---|
| 0 kg of N | 8.8 kg of P | 0 kg of K | 11 kg of S |

Therefore, the amount of nutrients in 1 tonne (1000 kg) of a fertiliser will be ten times the amount of nutrients in 100 kg. So, 1 tonne of single superphosphate with a nutrient analysis of 0:8.8:0:11 will contain:

| | | | |
|---|---|---|---|
| 0 kg of N | 88 kg of P | 0 kg of K | 110 kg of S |

Fertilisers used in Australia express the percentage of the individual nutrient in its elemental form e.g. 8.8% P for single superphosphate.

As you can see, 1 tonne of this single superphosphate contains a total of 198 kg of NPKS nutrients. The remaining 802 kg in the tonne contains the other elements that formed the less plant available forms.

The nutrient analyses of a typical single superphosphate and a typical triple superphosphate are shown as a diagram in Figure 11.2.

**Practice Exercise:**

Incitec Pivot Triple Super contains 0% N, 20.2% P, 0% K and 1% S

How many kilograms of N, P, K, and S are in 1 tonne (1000 kg) of Incitec Pivot Triple Super?

| | | | |
|---|---|---|---|
| | | | |

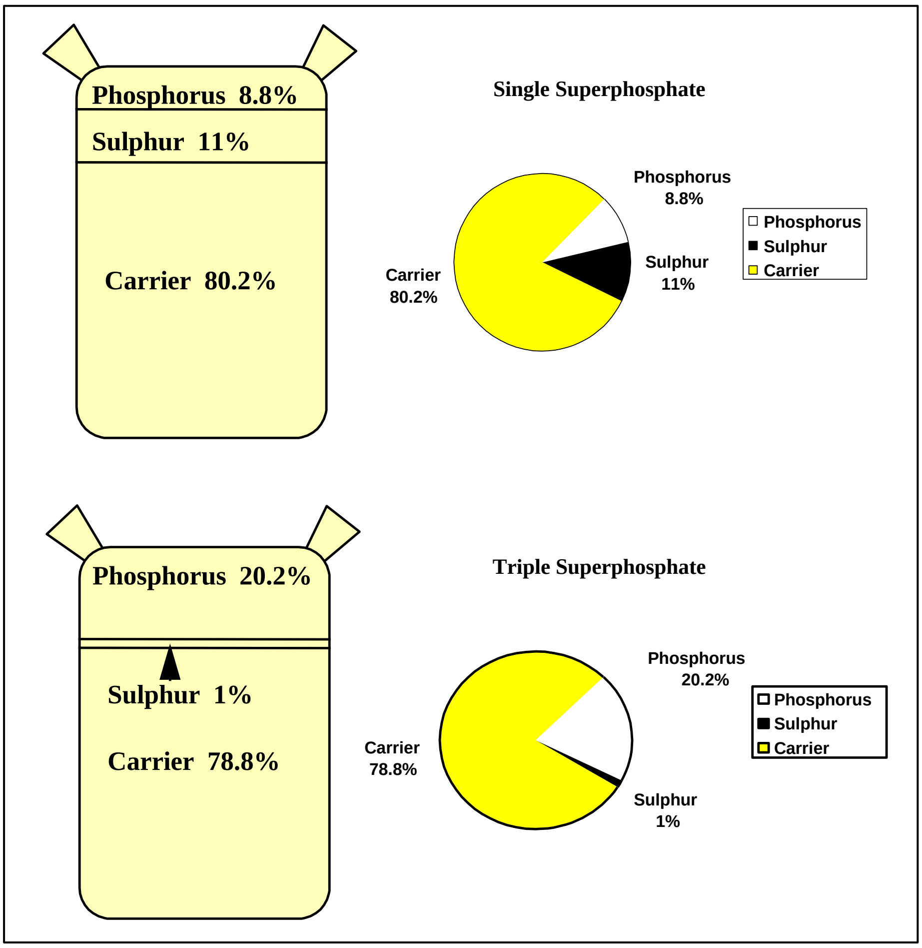


**Figure 11.2** Diagrammatic representation of typical single superphosphate and triple superphosphate nutrient analyses

## 11.4.2 Available or elemental versus total nutrient

Fertiliser nutrients are shown on fertiliser labels and in product charts in their elemental form (e.g. %N, % P, %K) however this is not how nutrients exist in their natural state in the soil or in fertilisers. For example, phosphorus exists in combination with other elements including calcium, oxygen, hydrogen, iron and aluminium. Collectively all these forms would add up to the total P, however only a relatively small fraction of this is plant available. Plants take up phosphorus in the phosphate or orthophosphate form ($H_2PO_4^-$, $HPO_4^{2-}$) which is water soluble and plant available. It is therefore important to know the water soluble percentage of the total P nutrient analysis in order to match the nutrient availability to pasture demand. These water soluble forms are changeable and may combine with other nutrients (calcium, iron or aluminium) over time to become less water soluble and less plant available.

Currently fertiliser companies are required to label fertilisers according to State legislation which stipulates that fertiliser labels provide the following detail:

- Total elemental form of a nutrient, e.g. %N.
- The forms in which the nutrients are presents, e.g. N as urea.
- The percentages of each form present (e.g. nitrate-N at 7.8% and ammonium-N at 4.8%).

There is an Australian National Code of Practice that will unify the state legislations, however it has not yet been formally recognised across state and territory borders.

### 11.4.3 Using the nutrient analyses to find comparable products

Once you know what nutrients you need to apply to your paddocks, you may want to compare products from different companies to see which nutrient analysis and price combination is the most cost-effective. Although the product names may not be similar, you can use the nutrient analyses given in the product lists to find similar products.

For example, you may want to apply a product containing phosphorus, potassium, and sulphur, such as Incitec Pivot SuPerfect Potash 2 & 1, which has a nutrient analysis of 0:5.9:16.6:7.3. The other product lists in Appendix G contain similar products, although the product names may not include the term ‘2 & 1’ or ‘super potash’.

## 11.5 Summary

- A fertiliser is any nutrient or substance that promotes plant growth.
- There are many individual types of fertilisers produced.
- Nutrient sources can be organic or inorganic.
- Fertiliser product lists and labels are required to show the product’s NPKS percentages.
- The NPKS system refers to the percentage of N, P, K, and S in fertiliser products.
- Fertiliser nutrients are mixed in with varying proportions with other less plant available forms; usually oxides.
- Fertilisers should be purchased on the basis of their nutrient analyses and ability to overcome a specific nutrient deficiency.

Exercises 7 and 8

## 11.6 References

Dairy Australia. (2012). ‘Dairying for Tomorrow Survey of Natural Resource Management on Dairy Farms’ Survey Report, Dairy Australia, Melbourne.